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Educational Underpinnings of Cognitive Load Theory

Tagaram Kondala Rao

Assistant Professor in Education, Faculty of Education, Dayalbagh Educational Institute (Deemed to be university), Agra, Uttar Pradesh, India

Abstract: ***The present education system has a lot of load in itself. As the education market increasing, the stakeholders of it are also looking to make the curriculum tougher and harder. The competitiveness is clearly visible in the content to be learnt rather than psychological satisfaction of the learning. It is often observed that the curriculum developers are keen to focus more on knowledge and skills in comparison to individual capabilities and pace of learning. When it comes to education system, the parents' expectations and society needs are far away from needs of the learner actually. Now the student has a big role to play to meet all those expectations. The students have to learn mathematics, they should speak English fluently, and they should get all the prizes in sports and so on. In the process, the learner may undergo a tremendous pressure for each activity he or she takes up. Somewhere, the cognitive fluctuations or cognitive conflict sets in mind and leading work very hard on. The learner has to process all the related incoming information in each and every area of subject he or she chooses, ultimately results in load on memory. As the amount of information to be processed heaps up, heavy cognitive load the outcome will be. Many past researches have been reviewed in this direction to come to solid conclusion.***

Keywords: Education, working memory, long term memory, stress, cognitive load theory

1. Introduction of Cognitive Load Theory (CLT)

Cognitive load is a form of intellectual strength that is necessary to process the learning material in a given context. Cognitive load theory advocates developing those kind of instruction designs that helps in effective learning. CLT works on two independent systems such as working memory for processing information and long term memory in which the learnt information is stored. Chi et al (1981) cited CLT as schema theory in where higher order schemata are developed on the basis of lower order ones, so that individuals could acquire and store information. However, it can be noticed that the long term memory does only storing, after processing by working memory. So the role of working memory is essential how it carries and processes the learning material. Being very limited in terms of capacity and duration, it is difficult for working memory to handle all the incoming learning material. This view was supported by Miller's magic number seven plus or minus two, where he demonstrated many experiments on short memory and concludes our working memory would only have seven plus or minus two chunks of information. It is well understood that these limitations are detrimental to learning. We often remember the information in different ways. People remember the information on the basis of what they already know, not by capturing the learning material just like a photograph. Another form of remembering is chunking, where we form the whole information into bits just like mobile number has 10 digits and it can be fitted into 3 chunks which make us easy to remember e.g. .9573004212-957 300 4212. There are also other theories such as modal model of memory that divide memory into 3 types and are sensory memory, working memory and long term memory. Sensory memory deals with incoming stimuli of senses in separation, for e. g. auditory memory last for 3 seconds whereas visual memory for about half a second. John Sweller (1988) developed cognitive load theory in the field of education and instructional design on the basis of working memory model proposed by Baddaley & Hitch (1974). Therefore, it may be said as one of the key areas of cognitive science.

2. Learning as a means of schemas acquisition in the light of past researches

The concept of learning is very broad and mostly occupies in psychology. In layman language, learning is relatively permanent change in behavior. Different psychology came up with different views regarding learning. Malcom Knowles (1984) while referring to 'Andragogy' defines learning as process of gaining knowledge and becoming expertise. Ruth C. Clark and Richard E. Mayer (2002) in their book on e-Learning and the Science of Instruction' shared their thoughts about learning. They defined learning is done by strengthening correct responses while reducing incorrect ones. Learning adds new knowledge to our memory; it makes sense of learning material being presented by attending. Organizing and connecting the relevant information on the basis of what we already know. Crow and Crow define learning is acquisition of knowledge, habits and attitudes. It is the way of adjustments to various new situations by overcoming the barriers in the middle. According to Henry Smith, learning involves acquisition of new behaviors. He further extends that the strengthening or weakening of old experiences as in the part of part of learning. Gates (1956) defines learning as behavior modification through experiences.

Based on the above definitions given by psychologists and educationalists, it can be clearly understood that learning is a process of adding new information, new knowledge, new habits and attitudes. To add new information, the learner has to develop new schemas that are helpful in processing the learning material on the basis of prior schemas already developed in the individual. When the learner encountered with new situations they are likely look back whether similar kind of situation occurred in the past. The learner try to

search for already formed schemas then connect it to emerging situation. By doing so, the learner not only searches for already developed schemas but also connects those into new situation. As we fit brick by brick with the help of cement, schemas are also fitted into together in order to form new knowledge is the fundamental principle of constructivism. It shall be noted that old schemas are likely to change and replaced by new schemas when and where needed. For instance, the child has formed a schema in the previous class without worked-example he or she has to modify that schema in the present class as they have clear understanding with the help of work-example. So, the new schemas are acquired and old ones are gone, learning happens. As far as the schemas are acquired, long term memory goes on widely. Jean Piaget (1951) studied extensively about the formation of schemas in his longitudinal classical studies of his own. Later, it came to be developed as theory of cognitive development. He explains how newborns develop schemas and how infants use their cognitive structures as a means of fulfilling their needs. As the age of child increase, the external environment is also widens. There, they may face odd situations which were not done in the past. At that time, they need to adapt to the challenging situation by forming new schemas and it leads to equilibrium. On the other hand, if the child has not adapted to the situation imbalance sets in and disturbs homeostasis. Ultimately, learning becomes effective otherwise it goes down to zero based on the adaptability or non-adaptability. Form the long discussion, it could be concluded that the schema acquisition is the primary element of learning without which learner con not move ahead in learning process.

Cognitive load as a road block for effective learning

Some of the strategies that we use in the classroom create barriers in learning process as they increase load on cognitive. They often add more stress on working memory and diminish available resources. They are as follows,

Poor designing of learning materials

Technically, it can be called as extraneous cognitive load which is done by instructional designer. These irrelevant and improper designing of instructional material would obviously hindering the formation of schemas in the students that hampers learning. Whatever the learning material that the teacher tries to present should be se sequentially arranged without any ambiguity. As the ambiguity increases, so does the cognitive load also. Though, it will not provide better understanding of concepts rather it confuses already developed schemas and taking the leaner into confusion and leading to under performance. At the same time, it will distance priceless resources of working memory from the task to be learned reported by chipperfield and Schwier (2004). So, the learning materials come in as a factor of learning process. Peeck (1993) demonstrated that the learning is enhanced when the text is integrated with text material. These finding further strengthened by Mayer, Bove, Bryman, Mars, & Tapangco (1996) saying that the learner may not learn better with text alone as the visual representation provide additional ways for obtaining knowledge. Similar findings were seen in Mathewson's (1999) work as he was very of the opinion 'visual representation are critical for learning of science concepts' as they make meaningful. In contrast, Wu, Krajcik, & Soloway (2001) reported that it was very difficult to understand graphical information. However, most of the researches done in the past have gone favored to the integration different types of learning materials together for better learning.

Wrong pedagogies

This is one of the important barriers of learning. Still it is evident that most of the public school teachers are using traditional pedagogical approaches in classroom. This might be the one of the many reasons for under achievement in government schools. These old traditional pedagogies, however do not provide learning opportunities rather creates obstacles in learning process and results in extraneous cognitive load. Traditional teaching methods do not help in conceptual clarity and goes over the heads and learner stuck in between when sat down to learn and leading to cognitive load. To reduce the negative impact of traditional methods, the web based instruction came into play the big role and it was developed to serve the purpose. Serkan Dinçer & Ahmet Doğanay (2015) reported that the computer assisted instruction proven to be useful as and when it provided on the psychological needs of students primarily focusing on personalized learning. They have also suggested multi pedagogical agents for instructional designers. Noah L. Schroeder & Olusola O. Adesope (2013) also found that the pedagogical agents were almost preferred by learners rather than non-pedagogical agents as they do provide motivational benefits to some particular students. However, they were not clear whether or not pedagogical agents contribute to extraneous cognitive load. Mayer, Dow, & Mayer (2003) also shown same findings and saying that the image of pedagogical agent always not necessary for affective interaction. The present emerging technologies such as flipped classroom, online teaching are also trying to reduce extraneous cognitive load. Zeynep Turan, Yuksel Goktas (2016) found flipped classroom is beneficial not only improving academic performance, but also reducing cognitive load in the students.

Psychological responses of cognitive load

There may be many affective aspects of cognitive load which are highly emotional. Some of the key components are discussed below.

Interest

Interest may said to be a motivated direction towards an activity or any task. The working memory resources are highly utilized when learners are interested in learning tasks and not feel much cognitive load since they are attentive. Csikszentmihalyi, (2015) interested learners would experience less task difficulty; focused attention and positive affect are associated to interest. High task performance and effort are correlated with learner's interest. Low interested learners feel high task difficulty whereas high interested learner perceive same task easier though they are putting more effort. Milyavskaya et al., 2018). Skuballa et al. (2019) also demonstrated same results and reported perceived task difficulty when learners had interested on the topic to be learnt. Therefore, it can be understood that the interest and cognitive load are related to each other and shown inverse relationship.

Stress

Most of the past researches focused on cognitive aspects of cognitive load, less work has been carried out on affective processes. Plass and Kalyuga (2019) did some empirical research and found that the cognitive load is affected by affective processes like learner's stress, enjoyment and emotion as these variables could influence working memory. Fraser et al. (2012) in their study found close association between stress-related invigorating emotions and higher perceived cognitive load. Knörzer et al. (2016) also observed early negative emotions such as stress in the beginning of a learning task. Nina Minkley, Kate M. Xu, and Moritz Krell (2021) in their study concluded that cognitive load was contributed by learner's self-concept and perceived stress.

Burnout

Burnout is an emotional response that human beings exhibit when they are overwhelmed by constant ongoing demands of prolonged stress. Brouwers, André; Tomic, Welko (1999) assessed teachers' burnout on the aspects of Perceived Self-Efficacy in Classroom Management, and Student Disruptive Behaviour and found that depersonalization and emotional exhaustion turn into cognitive load were the reasons of teachers' burnout. Teacher's perceived self-efficacy may be improved to overcome the burnout. Gan, Yiqun; Shang, Jiayin; Zhang, Yiling (2007) in their study on Coping Flexibility And Locus Of Control As Predictors Of Burnout Among Chinese College Students found that the burnout was brought down with coping flexibility, perceived controllability and strategy-situation. TE Virtanen, N Kiuru, MK Lerkkanen (2016) worked on Assessment of student engagement among junior high school students and associations with self-esteem, burnout, and academic achievement and they found that the high self-esteem and academic achievement are negatively associated with school burn out. Bergdahl et al., (2020); Silamut and Petsangsri, (2020) found that lack of digital competency caused struggling in online learning and experiencing high cognitive load and leading to academic burnout. These could have been the reasons for quitting the leaning in online nowadays.

How academic performance be improved?

Following the long discussion, we understand the various psychological consequences of cognitive load in the learners. There are some researches that focused on how academic performance can be used while using technological environments. Zhampeissova, K., Gura, A., Vanina, E. & Egorova, Z. (2020). In their work on Academic Performance and Cognitive Load in Mobile Learning found that mobile learning not only helped in academic performance, but also helped in reducing cognitive load. Cristian Vasile, Ana – Maria Marhan, Florence Mihaela Singer & Daniela Stoicescu (2011) confirmed in their experiment that the association between deeper understanding and academic performance through working memory. They also reported different processing patterns in boys and girls.

3. Conclusion

To make it more specific, cognition and affection cannot be separated from each other though we study these two are independent components. However, neurological researches also express the same view. In order to be excellent in the field of education, we should be very careful in designing all the instructional procedures and present them in an effective way. Otherwise, our efforts are going to be in vain unless or until we reduce cognitive load in the learner. The current trends in classroom practice posing challenging situations for a teacher. We, as a teacher needs to understand all the consequences of cognitive load and plan instructional events accordingly. Many researches support online learning, flipped classroom and other types virtual/mobile learning environments for better learning as they do reduce cognitive load in the students.

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